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|  | **Unit 1: Biochemistry** | | | | | | | | | | |
| Name: | | Start Date: | | | | 08/29/17 |  | |  | |  |
|  | | Test 1 Date: | | | | **09/25/17** |  | |  | |  |
| Period: (Honors) | | Teacher: Ms. Jost | | | | |  | |  | |  |
|  | |  |  |  |  | |  | |  | |  |
| **BIOCHEMISTRY** | | Submitted | Resubmit | Correct | Evidence of Learning | | Page # | | Date | | Sign-Off |
| **Objective 2:** Explain how enzymes act as catalysts for biological reactions | |  |  |  | **HW: Lactose Intolerance Article** | | | -- | | 9/11 |  |
|  |  |  | **Catalyst: Lactose Article Questions**  **BioInteractive: Lactose Intolerance**  **Video: Intro to Enzymes**  **HW: Lactase Pre-Lab** | | |  | |  |
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|  |  |  |  | |
|  |  |  | **Catalyst: Latin Roots**  **Notes: Enzymes**  **HW: Lactase Enzyme Lab Conclusion** | | |  | |  |
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|  | |  |  |  | **Catalyst: Enzymes Review**  **POGIL: Enzymes** | | |  | |  |
|  | |  |  |  |  | |
|  | |  |  |  | **QUIZ: Objective 2 (Enzymes)** | | |  | | **9/18** |

**Unit 1: BioChemistry**

Start Date: 08/28/17

Test 1 Date: 09/25/17

**Objective 1:** Compare the structures and functions of the major biological molecules, organic and inorganic, as related to the survival of organisms.

*Essential Question:* What are the subunits and functions of the four major groups of organic molecules?

*Essential Question:* What are the properties of water?

*“I Can” Statements:*

* Compare and contrast the four major organic macromolecule groups in terms of:
  + The formative elements
  + The formative subunits (monomers)
  + Functions within the cell/organism
  + Where found in the diet (food sources)
* Describe the major properties of water and explain the importance of these properties in the context of sustaining life:
  + Universal solvent
  + High specific heat
  + Adhesion and cohesion
  + Capillary action
  + Density

**Objective 2:**  Explain how enzymes act as catalysts for biological reactions.

*Essential Question:* How and why do enzymes catalyze biological reactions?

*“I Can” Statements:*

* Demonstrate the link between shape and function as it relates to an enzyme-substrate complex, as well as the effects of environmental factors (temperature, pH) on enzyme efficiency
* Develop a cause-and-effect model for specificity of enzymes

**Vocabulary**

* Activation Energy
* Adhesion
* Amino Acid
* Capillary Action
* Carbohydrate
* Catalyst
* Cohesion
* Denature
* DNA
* Density
* Enzyme
* Fatty Acid
* Hormone
* Inorganic
* Lipid
* Macromolecule
* Monomer
* Monosaccharide
* Nucleic Acid
* Nucleotide
* Organic
* Peptide Bond
* Polarity
* Polymer
* Polysaccharide
* Product
* Protein
* Reactant
* RNA
* Solvent
* Solute
* Substrate

**Catalyst 1: Article Response Questions**

1. What is the difference between lact**ose** and lact**ase**?

2. What does it mean to be lactose intolerant?

3. How can lactose intolerance affect someone’s health? What major nutrient is found in milk?

4. Name three ways people who are lactose intolerant might change their diet to manage their condition:

1.

2.

3.

**Catalyst 2: Latin Roots**

Use your Latin roots packet and work with the people around you to define the following terms:

**1. Mono/mer-**

**2. Poly/sacchar/ide-**

**3. Cata/lyst**-

**4. Re/act/ion-**

**5. De/nat/ure-**

**Introduction to Enzymes**

Video response questions:

1.What is an enzyme?

2. What does it mean to catalyze a reaction?

3. Where are digestive enzymes produced?

4. Where does digestion usually begin?

5. Proteins are primarily digested in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

6. How do the enzymes “digest” or break down the biomolecules?

7. How are nutrients distributed throughout the body?

8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ foods are rich in digestive enzymes.

9. How does ageing affect enzyme production?

Video: <https://www.youtube.com/watch?v=AFbPHlhI13g>

Biology I (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes: Enzymes Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

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Biology I (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Enzyme Lab Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Objective 2:**  Explain how enzymes act as catalysts for biological reactions.



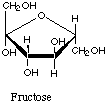
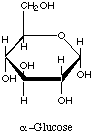
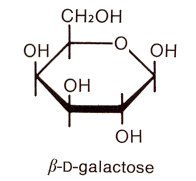
**Introduction:**

What is the topic of this ad? Who would use such a product? Why would they need it?

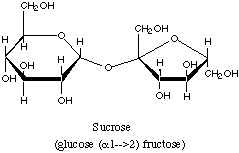
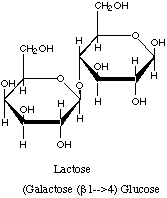
According to statistics, approximately one-third of all Americans feel ill after consuming milk and other dairy products. We were taught that we should “drink our milk” by our parents. “It is good for you, will help you have strong bones and teeth, and grow healthy and tall.” The nutritional value of milk is a fact. However, most animals stop drinking milk after they are weaned and their body chemistry changes so that they can no longer digest the sugar in milk. Worldwide this is also true of the human population. That is what is normal. It is actually unusual for adults to be able to digest milk easily.

In this lab activity, you will learn more about lactose intolerance. You will understand the chemical structure of lactose, why a person may have difficulty digesting milk, how lactose tolerance may have started, why so many Americans can digest it, and how lactose-reduced products can help people.

Lactose, the sugar found in milk, is a disaccharide composed of glucose and galactose (both six-sided sugars). Sucrose, ordinary table sugar, is also a disaccharide composed of fructose and glucose. Glucose is a six-sided sugar and fructose is a five-sided sugar.

Fructose Glucose Galactose

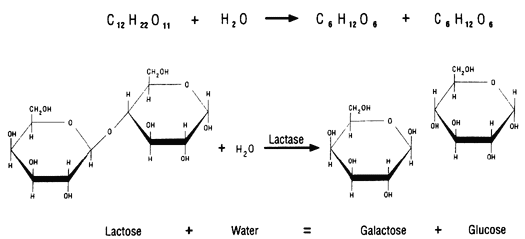
 

Sucrose Lactose

(Glucose + Fructose) (Galactose + Glucose)

Lactase is an enzyme that breaks lactose down into galactose and glucose. Lactase can be purchased in pill form by people who are lactose intolerant. These people lack the enzyme lactase, and cannot break down the sugar lactose into its component parts. Lactase is specific to lactose sugar and will not break down other disaccharides.

C12H22O11 + H2O → C6H12O6 + C6H12O6



Lactose + Water → Galactose + Glucose

In this lab, you will see lactase break lactose down into galactose and glucose by testing for the presence of glucose with glucose test strips. You will also observe what happens when lactase is added to sucrose and what happens if previously boiled lactase is added to lactose.

**PreLab Questions:**

1. What type of sugar is found in milk?
2. What two monosaccharides make up this sugar?
3. What type of biomolecule is lactase?
4. What is the difference between lactase and lactose?
5. What determines whether someone can digest lactose?

*Procedure Questions: Read the lab procedure and introduction to answer the questions below.*

1. What enzyme is being tested in this lab? What substrate does this enzyme work on?
2. What reaction is being tested?
3. How will the presence of glucose be tested?
4. If a sample tests positive for glucose, what can be assumed about the enzyme activity?

**Materials**

* Droppers
* Glucose test strips
* Lactase enzyme solution
* Lactase solution - boiled
* Lactase solution – (Acidic pH)
* Microwell plate
* Milk
* Sucrose solution
* White paper towel

**Procedure:** Assume that each well represents a person.

1. Put the microwell plate on a white paper. Label the well plate A, B, C, D, E, and F by writing on the paper towel.
2. In well A add 10 drops of milk and 5 drops of water. This represents a person who is lactose intolerant.
3. In well B add 10 drops of milk and 5 drops of lactase enzyme solution. This represents a person who has the lactase enzyme and can digest milk.
4. In well C add 10 drops of milk and 5 drops of boiled lactase enzyme solution. This represents a person who has the lactase enzyme, but boiling the enzyme has caused denaturation.
5. In well D add 10 drops of milk and 5 drops of basic (pH 11) lactase enzyme solution. This represents a person who has the lactase enzyme, but changing the pH of the enzyme has caused denaturation.
6. In well E add 10 drops of sucrose solution and 5 drops of lactase enzyme solution. This represents a person who has the lactase enzyme, but chooses to avoid consuming dairy products.
7. In well F add 10 drops of glucose solution. This represents a control for the experiment.
8. Dip the blue end of a glucose test strip into each well plate. Leave for a minute or so.
9. Set each glucose strip on a paper towel next to the corresponding well plate hole.
10. Wait ten minutes to read the results.
11. Record data in table. If there was glucose present mark a ‘+’ in the table. If glucose was absent, mark a ‘**―**’ in the table.

**Apparatus:**

Milk Milk Milk

**A** Water **B** Enzyme **C** Boiled enzyme

Milk Sucrose Glucose

**D** Acidic enzyme **E** Enzyme **F**

**Data**

|  |  |
| --- | --- |
| **Table 1: Glucose presence in the following solutions** | |
| **Type of solution** | **Positive or Negative glucose result** |
| **A:** Milk and water |  |
| **B:** Milk and lactase enzyme solution |  |
| **C:** Milk and boiled lactase enzyme solution |  |
| **D:** Milk and (acidic pH) lactase enzyme solution |  |
| **E:** Sucrose solution and lactase enzyme solution |  |
| **F:** Glucose solution |  |

**Analysis & Conclusion**

1. *Diagram* and *describe* the lactose and lactase reaction. *Label* the reactants and products.   
   You may use simple shapes for the drawings of the molecules (see pages 1 and 2 of this lab).
2. Did the enzyme break down sucrose? Why or why not?
3. Why did the enzyme react to lactose but not to sucrose?
4. What was the result of changing the pH of the enzyme solution? What might this suggest about enzyme function and pH?
5. What was the result of mixing the boiled enzyme with lactose? What might this suggest about enzyme function and temperature?
6. Write a concluding paragraph about this experiment.   
   - Start by restating the purpose of the lab in past tense.   
   - Then name and describe the function of the enzyme explored in this investigation.   
   - What did the results indicate about conditions necessary for proper enzyme function?   
   - What did you learn about enzymes by doing this lab?

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Biology (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Catalyst: Enzymes Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Objective 2:** Explain how enzymes act as catalysts for biological reactions.

1. In the space below draw a diagram of an enzyme catalyzing a reaction and label the diagram using the following words:
   1. Active Site
   2. Enzyme
   3. Products
   4. Enzyme-substrate complex
   5. Reactant
2. Answer *True* or *False* to the following statements:
   1. Enzymes only interact with one specific substrate \_\_\_\_\_\_\_\_\_\_
   2. Enzymes change shape after a reaction occurs \_\_\_\_\_\_\_\_\_\_
   3. Enzymes speed up reactions \_\_\_\_\_\_\_\_\_\_
   4. One enzyme can be used for many different types of chemical reactions \_\_\_\_\_\_\_\_\_\_
3. Circle the correct effect
   1. Raising the temperature [*increases | decreases | does not change*] the rate of reaction.
   2. Changing the pH away from normal will [*increase | decrease | not change*] the rate of reaction.
4. Explain the graph below using the following words:
   1. Activation Energy
   2. Products
   3. Reactant
   4. With enzyme
   5. Without enzyme

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5.** Illustrate the difference between competitive inhibition, and non-competitive inhibition of enzymes in the space below. Use captions to explain your drawings.

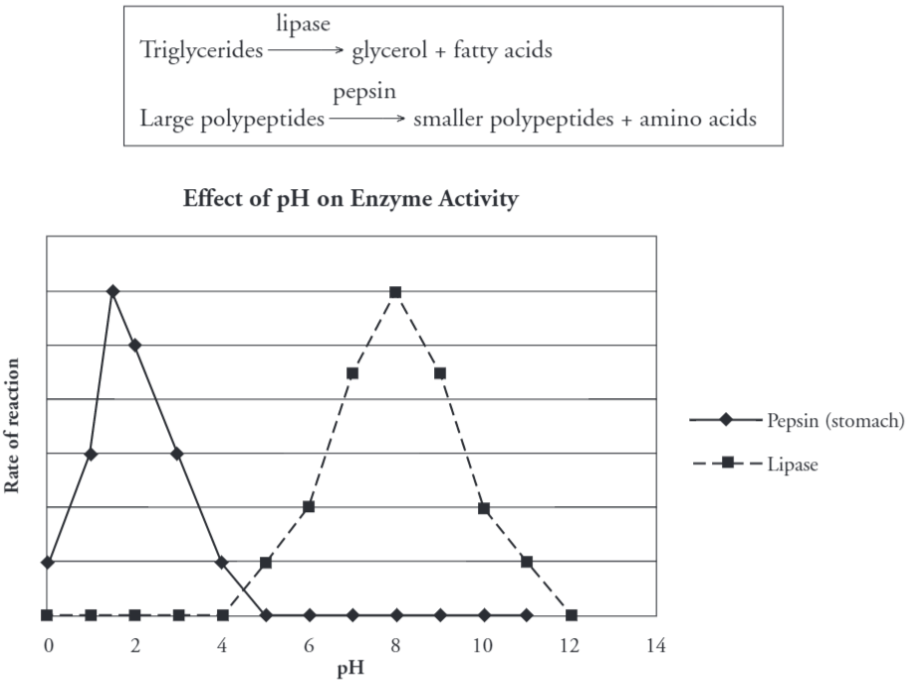
Biology (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

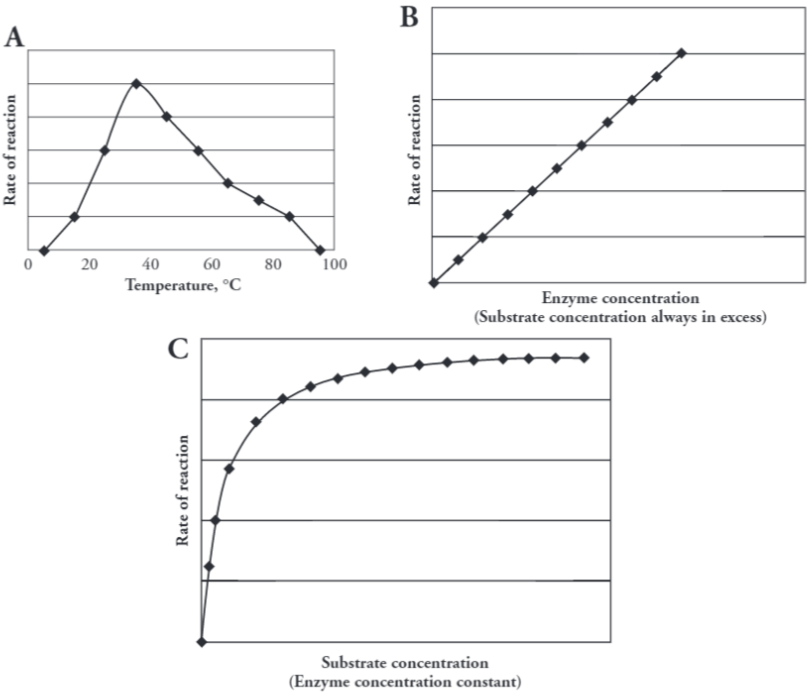
POGIL: Enzymes & Cellular Regulation Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Introduction**

Digestive enzymes are protein-based biological catalysts that play important roles in our lives. They help remove stains from our shirts, turn milk into cheese, and are responsible for turning our dinner into useable fuel for our bodies. Enzymes, however, do not work well universally. Some are meant to work at high temperatures, others at low temperatures. They may work best in acidic conditions or neutral conditions. In this activity, we will look at the optimal conditions for two different enzymes. The digestive enzyme lipase is made in the pancreas and breaks down lipids in the small intestine, while pepsin breaks down proteins in the stomach.

**Model 1 – Two Digestive Enzymes**



1. Name the two enzymes illustrated in Model 1 above:
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Consider the information in the Introduction section above and in Model 1 about these proteins.
   1. In which body organ is pepsin active? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. In which body organ is pancreatic lipase active? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. For each enzyme in Model 1, circle the pH that best represents the environment in which the enzyme is *most* active:
   1. Pepsin 1.5 8.0 10.4
   2. Lipase 1.5 8.0 10.4
4. Compare the rate of the pepsin-catalyzed reaction at pH 1.5 with the rate of the lipase-catalyzed reaction at pH 1.5.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Compare the rate of the pepsin-catalyzed reaction at pH 8.0 with the rate of the lipase-catalyzed reaction at pH 8.0.  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Using your knowledge of protein structure, explain in detail the effect of exposing an enzyme to a pH outside of its optimal range. Include the effect on both enzyme structure and function.  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. At what pH values is lipase likely to be denatured? Justify your answer.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. At what pH values is pepsin likely to be denatured? Justify your answer.  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. In addition to being produced in the pancreas, lipase is also produced in the stomach. Is the structures of pancreatic lipase the same as gastric (produced in the stomach) lipase? Justify your reasoning.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
10. Add a line to the graph in Model 1 that shows a prediction for gastric lipase activity.
11. Antacids work by neutralizing acids, bringing the pH of the stomach to a range of 6-7. What is the effect of taking an antacid on a person’s ability to digest proteins?  
    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
      
    **Model 2 – Amylase Rate of Reaction**
12. Amylase is an enzyme that catalyzes the digestion of carbohydrates. The graphs in Model 2 provide data on several factors that affect the function of amylase in the body.
    1. The relationship of which two variables is illustrated in Graph A of Model 2?  
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. The relationship of which two variables is illustrated in Graph B of Model 2?  
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    3. The relationship of which two variables is illustrated in Graph C of Model 2?  
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
13. Refer to Model 2 as you answer the following questions:
    1. What is the optimum temperature for amylase to function correctly?  
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. What is the biological significance of the temperature at which the amylase-catalyzed reaction is fastest?   
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
14. Predict what causes a decrease in enzyme activity at temperatures above 37°C.  
    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
15. A young child runs a fever of 40°C for 24 hours. Explain what effect this may have on his/her digestion.  
    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
16. Consider the data in Graph B of Model 2.
    1. Describe the relationship between enzyme concentration and reaction rate.   
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. Propose an explanation for this relationship.   
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
17. Consider the data in Graph C of Model 2.
    1. What is the relationship between substrate concentration and the reaction rate?   
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. Propose an explanation for why a maximum reaction rate is reached in Graph C.   
       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
18. As a group, develop an analogy for the function of an enzyme that will explain the concentration Graphs in Model 2 (Graphs B and C).   
    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
19. Would the reaction rate on Graph B of Model 2 ever reach a maximum level? Justify your answer.   
    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
20. Thermophilic (heat-loving) bacteria, such as *Thermus aquaticus*, live in hot springs where the temperature is greater than 70°C. Draw a graph similar to Graph A in Model 2 representing the optimal temperature of *Thermus aquaticus*.